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LII.—*On the Reproductive Organs of* Phreoryctes. By Frank E. Beddard, M.A., Prosector to the Zoological Society of London.

[Plate XXIII.]

Among a number of earthworms which I have recently received from New Zealand was a single example of a small slender worm, which I refer, with some doubt, to the genus *Phreoryctes*. The specimen was in a very fair state of preservation, and I have therefore been able to investigate its structure by means of sections. The anterior region of the body, comprising the first twenty segments, was cut into a series of longitudinal sections; the posterior region was studied by means of transverse sections. Mr. W. Smith, of Ashburton, New Zealand, to whose kindness I am indebted for the worm, states that it was found in marshy soil coiled up with a number of others into a ball; its colour during life was a bright red. It is about 2 inches in length and very slender; its general proportions in fact agree very closely with Vejdovsky's figure of *Stylodrilus* ('System und Morphologie der Oligochaeten,' Taf. xi. fig. 9 *a*); its form is not nearly so elongated as that of either of the two species of *Phreoryctes* at present known.

With regard to external characters the genus *Phreoryctes* is distinguished by two peculiarities. Both Leydig ("Ueber *Phreoryctes Menkeanus*," Arch. für mikr. Anat. 1865) and Timm ("Beobachtungen über *Phreoryctes* &c.," Arb. a. d. Zool.-Zoot. Inst. Würzburg, Bd. vi. 1883) describe the setæ of *P. Menkeanus* as *disposed in four rows of a single seta each*. Vejdovsky ('System,' &c., p. 49) states of the second species, *P. filiformis*, "Die Borsten stehen in vier Reihen und je einzeln in jedem Borsten-follikel; doch in nicht seltenen Fällen erscheint auch neben der alten Borste eine fast völlig erwachsene Ersatzborste, so das es den Anschein hat, als ob das betreffende Borstenbündel aus zwei Borsten zusammengesetzt würde." It is therefore important to note that in my species *the setæ are invariably paired*; their shape moreover (Pl. XXIII. fig. 10) appears to be rather different from that of the seta figured by Vejdovsky ('System,' &c. pl. xii. fig. 6).

The second peculiarity of *Phreoryctes* is the incomplete division of the prostomium into two rings by a transverse furrow; I have found this to be the case in my species (Pl. XXIII. fig. 2), and this is one of the chief reasons which leads me to place my specimen in the genus *Phreoryctes*, with which, moreover, it has apparently other points in common to be referred to later.

The arrangement of the pairs of setæ with respect to each other can be understood from an inspection of Pl. XXIII. fig. 7, which represents a transverse section through one of the posterior segments; the two dorsal pairs are much nearer to each other than are the two ventral pairs or the dorsal and ventral pairs of one side.

There is a marked difference in size between the dorsal and ventral setæ, as is the case in *P. filiformis*, the dorsal being far stouter. This is, however, not the case in the anterior segments of the body.

The facts in the internal structure of the worm, to which I wish to direct attention in the present paper, concern the reproductive organs and their ducts (Pl. XXIII. fig. 3).

Our knowledge of these is at present extremely limited. Vejdovsky was unable to find any trace of the reproductive organs in *P. filiformis*. Leydig and Timm have, however, given some details with respect to *P. Menkeanus*. There are said to be four pairs of testes lying in segments ten, eleven, twelve, and thirteen (the ninth, tenth, eleventh, and twelfth setigerous segments); Vejdovsky suggests that these glands are probably ovaries and testes, and I am in a position to prove his supposition to be right, supposing of course that I

am right in referring the present worm to the genus *Phreoryctes*.

Testes.—There are two pairs of these organs, situated in segments ten and eleven; they are attached to the anterior septa of their segment to the outside of the ventral pair of setæ. The testes are large bodies and occupy a very considerable portion of their segment; so far as their shape can be made out by sections they appear to be irregularly conical in form, the apex forming the point of attachment. In the possession of two pairs of testes and in the position of these organs *Phreoryctes* agrees with the majority of earthworms; the only ally of the Lumbriculidæ which has an identical arrangement is *Ocnerodrilus* (Eisen, Acta reg. Soc. Upsala, 1878), and Vejdovsky has already indicated some of the points of resemblance which this latter genus bears to the terricolous forms.

Vasa deferentia.—No sexual ducts have hitherto been recorded in *Phreoryctes*, neither vasa deferentia nor oviducts. Leydig and Timm suggest that the nephridia, which occupy the segments where they should be found, perform the functions of reproductive ducts. The occurrence, however, of nephridia in the generative segments is now known through the researches of Vejdovsky. Nephridia are present in these segments *before* the sexual ducts make their appearance; it is probably, as Vejdovsky suggests, this fact which misled Leydig and Timm into regarding the nephridia of the genital segments as fulfilling the office of vasa deferentia and oviducts. It would obviously be of the greatest possible interest if the suggestion of Leydig and Timm should prove to be correct; it cannot, however, be correct if my species is a *Phreoryctes*, for I have succeeded in finding both vasa deferentia and oviduct.

The vasa deferentia correspond in number to the testes, that is to say there are two pairs of them. The funnels are flattened disks (Pl. XXIII. fig. 6) closely applied to the septum; they are perfectly simple in form, not plicated; and as their epithelium is composed of rather small columnar ciliated cells they were not readily found. The funnels lie in segments ten and eleven just opposite to the attached end of the testes. From the inner corner of each funnel arises the vas deferens, which is a ciliated tube composed of a single layer of columnar cells. The vas deferens passes through the septum and opens on to the exterior a little to the outside of the ventral pair of setæ; the important fact to be noticed bout the vasa deferentia of this worm is that *all the four vasa deferentia open independently, and there are no atria*.

At the aperture of the vas deferens the cuticle of the epidermis was continued for a short distance up the tube.

There are thus four male pores situated a little to the outside of the ventral setæ and disposed in pairs, one pair to each of segments eleven and twelve. The structure and position of the male reproductive ducts is, so far as is known at present, unique among the Oligochæta. *Acanthodrilus* and *Moniligaster* are not really comparable in these particulars, as might be inferred from Vejdovsky's work upon the Oligochæta. In *Acanthodrilus* the vasa deferentia of each side unite and open upon the eighteenth segment independently of the two pairs of atria, which open on to the seventeenth and nineteenth segments respectively. In *Moniligaster* the supposed anterior pair of male reproductive pores are in all probability spermathecæ (Beddard, "On the Reproductive Organs of *Moniligaster*," Zool. Anz. Bd. x.). At the same time the simplicity of the efferent ducts in *Phreoryctes* suggests that they are in a primitive condition.

Ovaries.—There are two pairs of ovaries, a pair to each of segments twelve and thirteen. In position and general shape they are precisely like the testes. The number of ripe ova in each ovary is small, as in most of the lower Oligochæta. The presence of two pairs of ovaries is extremely unusual, and there is of course the possibility to be considered that it is abnormal in the present case. There are, however, as I shall point out further on, two pairs of oviducts; and this fact (coupled with the observations of Leydig and Timm) is confirmatory of the view that *two pairs of ovaries are characteristic of the genus* Phreoryctes.

Vejdovsky particularly states that the Oligochæta possess only one pair of ovaries, and believes that the supposed three pairs of ovaries of *Euclipidrilus* (Eisen, *loc. cit.*) are testes and seminal vesicles. Lankester ("The Sexual Form of *Ch. limnæi*," Q. J. M. S. 1869) notes that in *Chætogaster limnæi* there are occasionally two pairs of ovaries, but Vejdovsky finds himself unable to confirm this observation. In any case it is certain that a second pair of ovaries is occasionally met with in *Lumbricus* (Bergh, "Geschlechtsorgane der Regenwürmer," Zeitschr. f. wiss. Zool. 1886) and in *Perionyx* (Beddard, "Variations in *Perionyx*," Proc. Zool. Soc. 1886). The fact of there being two pairs of oviducts in *Lumbriculus* (Vejdovsky, 'System und Morph.' &c. p. 150, note) suggests that in that Annelid a second pair of ovaries may exist.

Oviducts.—*Phreoryctes* differs from all Oligochæta except *Lumbriculus* in the fact that *there are two pairs of oviducts opening on a line with the ventral pair of setæ between segments*

twelve and thirteen, and thirteen and fourteen. I have myself recorded the occasional presence of two pairs of oviducts in *Perionyx* (*loc. cit.*), where, however, it is a very rare occurrence. It is I think a fair assumption that the one specimen of *Phreoryctes* at my disposal exhibits the normal characteristics of the genus.

The oviducal funnels resemble in every particular, except that they are a little smaller, the funnels of the vasa deferentia, and they occupy a corresponding position in segments twelve and thirteen. Each funnel is connected with a tube whose structure is identical with that of the vas deferens; this tube is, comparatively speaking, of some length, and passes closely adherent to the opposite side of the septum to that which bears the funnel to its point of opening, which is upon the intersegmental furrow.

The position of the oviducal pores, behind the male pores, agrees with that of Lumbriculidæ, as does also their position upon the intersegmental furrow.

The close agreement between the ducts as well as the glands of the male and female reproductive systems in *Phreoryctes* is more apparent than in any other Oligochæta; it is probably to be looked upon as an indication that the reproductive system of this Annelid is in an archaic condition. The ovaries and testes correspond *in number* as well as in their other particulars which *Phreoryctes* shares with the remaining genera of Oligochæta. The oviducts and vasa deferentia approximate more closely than in any other genus; they only just show indications of differentiation.

Spermathecæ.—There are two pairs of these organs; the anterior pair lie in segment seven, the second pair in segment eight; each spermatheca is a somewhat pyriform pouch lined with a columnar epithelium having a glandular appearance; the apertures of the spermathecæ are on the anterior border of their segment between the dorsal and ventral pairs of setæ. The spermathecæ are not furnished with diverticula of any kind. Leydig and Timm describe three pairs of spermathecæ in *P. Menkeanus* situated in segments seven, eight, and nine; these are said to be distinguished by their extraordinarily thick and muscular walls. They are certainly not so in my species.

It will be clear from the foregoing description that the worm belongs to a distinct species, for which I propose the name of *Phreoryctes Smithii* *, and it may ultimately prove to be a distinct generic type. In favour of this view is the

* Named after Mr. W. Smith, of Ashburton, New Zealand.

paired character of the setæ. There is, however, evidently a close agreement, if not identity, between the reproductive organs of this species and of *P. Menkeanus*, and in most other points of structure they agree; so that I am not disposed to create a new genus, at least for the present.

The facts which I have been able to record in this paper confirm the justice of separating *Phreoryctes* as the type of a distinct family, as has been done by Claus and Vejdovsky.

Vejdovsky's definitions may be thus amended:—

Fam. **Phreoryctidæ**, Claus.

Long slender worms, the body made up of numerous segments; prostomium divided into two by a furrow; setæ in four rows, a single seta or a pair of setæ to each row, ∫-shaped, not bifid. Nephridia persistent in the segments behind those containing the reproductive organs, opening on to the exterior behind, or in front of, the ventral setæ. Testes in segments ten and eleven; ovaries in segments twelve and thirteen; four vasa deferentia opening on to segments eleven and twelve between dorsal and ventral setæ; four oviducts opening between segments twelve and thirteen, and thirteen and fourteen. Spermathecæ, two to three pairs in front of testes, in segments seven, eight (nine).

Genus Phreoryctes, Hoffmeister.

With the characters of the family.

Species:—

(1) *Phreoryctes Menkeanus*, Leydig.

Excessively slender, reaching to the length of 1 foot. Setæ in four rows of a single seta each; ventral setæ stouter than dorsal. Three pairs of spermathecæ in segments seven, eight, and nine. Nephridia opening in front of setæ.

(2) *Phreoryctes filiformis*, Vejdovsky.

Slender, but smaller than *P. Menkeanus*. Setæ in four rows of a single seta each, the dorsal setæ longer than the ventral. Nephridia open behind setæ.

(3) *Phreoryctes Smithii*, n. sp.

Much shorter than either *P. Menkeanus* or *P. filiformis*.

Setæ in four rows of pairs; dorsal setæ (in posterior region of body) much longer than ventral. Nephridiopores in front of ventral setæ. Two pairs of spermathecæ in segments seven and eight.

EXPLANATION OF PLATE XXIII.

Fig. 1. *Phreoryctes Smithii*, nat. size.
Fig. 2. Anterior segments from ventral aspect, magnified. *sp*, spermathecal pores, ♂ openings of vasa deferentia, ♀ openings of oviducts.
Fig. 3. Genital segments. *t*, testes; *o*, ovaries; *v.d*, vasa deferentia; *o.d*, oviducts; *sp*, spermathecæ; *s*, setæ; *n*, nerve-cord.
Fig. 4. Fragment of testis, highly magnified.
Fig. 5. Fragment of ovary, highly magnified.
Fig. 6. Section through funnel of vas deferens. *st*, septum; *f*, funnel; *v.d*, vas deferens.
Fig. 7. Section through one of posterior segments. *s*, setæ; *n*, nerve-cord; *al*, intestine; *d.v*, dorsal vessel; *v.v*, ventral vessel; *np*, nephridium.
Fig. 8. Surface view of the nephridiopore (*np*) and setæ (*s*).
Fig. 9. Spermatheca, transverse sections. *a*, near to external orifice; *b*, near distal end.
Fig. 10. Seta.

LIII.—*Notes on the Palæozoic Bivalved Entomostraca.*—No. XXV. *On some Silurian Ostracoda from Gothland**. By Prof. T. Rupert Jones, F.R.S., F.G.S.

[Plates XXI. & XXII.†]

Prof. Gustav Lindström, of the State Museum, Stockholm, having confided to me in 1886 a fine series of Ostracoda from the Silurian rocks of Gothland for examination, I had much pleasure in 1887 in comparing them with such as are known from other countries and in determining what seemed to me to be their generic and specific alliances. Late researches among the British species, especially those collected by Messrs. J. Smith and G. R. Vine in Shropshire ‡, enabled me to arrive at conclusions more confidently than I could otherwise have done; and the results were given by me in the

* For No. XXIV. see Ann. & Mag. Nat. Hist. for June 1887.

† These Plates have been drawn with the aid of a grant from the Royal Society for illustrating the fossil Entomostraca.

‡ Ann. & Mag. Nat. Hist. for April 1886, May 1886, March 1887, and June 1887.